CONVECTIVE BOUNDARY LAYER FLOW OF JEFFREY FLUID AND JEFFREY NANOFLUID OVER VARIOUS GEOMETRY

SYAZWANI MOHD ZOKRI

DOCTOR OF PHILOSOPHY

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR’S DECLARATION

We hereby declare that We have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy.

____

(Supervisor’s Signature)

Full Name : ASSOC. PROF. DR. MOHD ZUKI SALLEH

Position : ASSOCIATE PROFESSOR

Date : SEPTEMBER 2019

____

(Co-supervisor’s Signature)

Full Name : DR. ABDUL RAHMAN MOHD KASIM

Position : SENIOR LECTURER

Date : SEPTEMBER 2019

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

____

(Student's Signature)

Full Name : SYAZWANI MOHD ZOKRI

ID Number : PSE15005

Date : SEPTEMBER 2019

CONVECTIVE BOUNDARY LAYER FLOW OF JEFFREY FLUID AND JEFFREY NANOFLUID OVER VARIOUS GEOMETRY

SYAZWANI MOHD ZOKRI

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Doctor of Philosophy

Faculty of Industrial Sciences & Technology

UNIVERSITI MALAYSIA PAHANG

SEPTEMBER 2019

In dedication to:

My beloved Abah and Ma,
Mohd Zokri Abdul Ghani & Noriah Saleh

My lovely siblings,
Fathi, Faiz, Fakhruddin, Farhan, Syamimi, Fawwaz & Fayyadh

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious, and the Most Merciful. All praises belong to Him, the Lord of the World. May shalawat and peace be upon the Prophet Muhammad SAW, his family and companions, and also for the people who are following and continuing the right path. I am so grateful to Allah for enabling me, His weak servant to accomplish my PhD successfully. Without Allah's help, there could have been no justification for the existence of my research.

First and foremost, I would like to express my deepest gratitude to my supervisor, Assoc. Prof. Dr. Mohd Zuki Salleh and co-supervisor, Dr. Abdul Rahman Mohd Kasim for their persistent help, superior guidance, constructive suggestions, passionate, encouragement and endless support from the initial to the final level, which has enabled me to unleash my potential as an applied mathematician. Completion of the thesis would not have happened if it was not through their generous effort and time poured into it. I am truly blessed to have both supportive supervisors along this challenging journey.

Special thanks also go to my fellow friends who were instrumental in making my journey here a memorable and pleasurable one: Mila, Kak Laila and Kak Nani. I highly appreciate the words of motivation, ideas, comments, suggestions and support that had contributed to the improvement of my thesis. Last but not least, I would like to acknowledge my wholehearted thanks especially to my parents and siblings for their never ending dua's, love and support.

ABSTRAK

Model bendalir Jeffrey bukan Newtonan menggambarkan sifat likat anjal yang menjelaskan dual komponen pengenduran dan perencatan masa. Kelikatan ricih yang tinggi, penipisan ricih dan tegasan alah adalah ciri penting model bendalir ini, yang sangat berkaitan dengan industri polimer. Kelebihan bendalir Jeffrey adalah bahawa ia boleh diturunkan kepada bendalir Newtonan pada tegasan ricih dinding yang sangat tinggi, dengan syarat tegasan ricih dinding lebih besar daripada tekanan alah. Disebabkan itu, kajian yang dicadangkan di sini bertujuan untuk mengkaji model matematik untuk aliran olakan paksa, bebas dan campuran bendalir Jeffrey. Aliran yang disebabkan oleh pelbagai permukaan seperti lembaran peregangan, lembaran peregangan condong dan silinder bulat mengufuk di bawah kehadiran atau ketidakhadiran zarah nano dipertimbangkan. Analisis aliran untuk zarah nano dilaksanakan berdasarkan model Buongiorno. Masalah spesifik dikaji dengan beberapa kesan termasuk pelesapan likat, hidrodinamik magnet dan sinaran terma. Perumusan matematik dimulai dengan penjelmaan persamaan menakluk berdimensi ke dalam bentuk tak berdimensi menggunakan pemboleh ubah tak berdimensi yang sesuai. Pemboleh ubah penjelmaan keserupaan dan ketakserupaan masing-masing digunakan untuk mengurangkan bilangan pemboleh ubah bersandar atau tak bersandar. Persamaan terbitan biasa atau separa yang terhasil kemudiannya diselesaikan secara berangka melalui skim perbezaan terhingga tersirat, iaitu kaedah kotak-Keller. Algoritma berangka dibangunkan dalam perisian MATLAB untuk mendapatkan penyelesaian berangka. Pengesahan hasil berangka dicapai melalui perbandingan dengan hasil yang terdapat dalam kajian sedia ada. Keputusan berangka profil halaju, suhu dan kepekatan serta pekali geseran kulit, nombor Nusselt dan Sherwood untuk nisbah pengenduran kepada perencatan masa, nombor Deborah, parameter olakan campuran, nombor Prandtl, nombor Eckert, parameter keapungan kepekatan, gerakan Brownian, parameter resapan thermophoresis dan nombor Lewis dibentangkan secara grafik dan dianalisis secara terperinci. Penemuan mendedahkan bahawa, tingkah laku yang bercanggah pada kedua-dua parameter bendalir Jeffrey diperhatikan, tanpa mengira geometri permukaan yang dipertimbangkan. Kehadiran zarah nano dalam bendalir Jeffrey telah meningkatkan profil suhu dan seterusnya meningkatkan pemindahan haba. Aliran mengalir melalui silinder bulat mengufuk mendedahkan bahawa pemisahan lapisan sempadan untuk bendalir nano Jeffrey lebih tertunda daripada bendalir Jeffrey untuk parameter olakan campuran. Menunda pemisahan lapisan sempadan sehingga ke akhir permukaan silinder boleh mengurangkan seretan. Pemisahan ini biasanya tidak diingini dalam aplikasi kejuruteraan kerana jumlah tenaga yang banyak hilang dalam proses perolakan.

ABSTRACT

Non-Newtonian Jeffrey fluid model describes the viscoelastic property that elucidates the dual components of relaxation and retardation times. High shear viscosity, shear thinning and yield stress are the important features of this fluid model, which is profoundly relevant with the polymer industry. The advantage of Jeffrey fluid is that it can be reduced to Newtonian fluid at very high wall shear stress, provided that the wall shear stress is much greater than the yield stress. Owing to these reasons, the proposed study herein aims to examine the mathematical models for forced, free and mixed convection flows of Jeffrey fluid. Flow that is induced by various surfaces such as stretching sheet, inclined stretching sheet and horizontal circular cylinder under the absence or presence of nanoparticles is considered. The flow analysis for nanoparticles is performed based on the Buongiorno model. Specific problems are studied with several effects including viscous dissipation, magnetohydrodynamic and thermal radiation. Mathematical formulation starts with the transformation of dimensional governing equations into dimensionless form using the appropriate non-dimensional variables. Similarity or non-similarity transformation variables are applied to reduce the respective number of dependent or independent variables. The resulting ordinary or partial differential equations are then solved numerically via the implicit finite difference scheme, namely the Keller-box method. Numerical algorithm is developed in MATLAB software to obtain the numerical solutions. Authentication of the numerical results is achieved through comparison with the results available in the existing literature. The numerical results of velocity, temperature and concentration profiles as well as skin friction coefficient, Nusselt and Sherwood numbers for ratio of relaxation to retardation times, Deborah number, mixed convection parameter, Prandtl number, Eckert number, concentration buoyancy parameter, Brownian motion, thermophoresis diffusion parameter and Lewis number are presented graphically and analysed in details. Findings disclose that, the contradictory behaviours of both Jeffrey fluid parameters are observed over the specified distributions, regardless of the surface geometry under consideration. The presence of nanoparticles in Jeffrey fluid has enhanced the temperature profiles and consequently enhanced the heat transfer. Flow passing through the horizontal circular cylinder reveals that the boundary layer separation for Jeffrey nanofluid is more delayed than the Jeffrey fluid for dissimilar mixed convection parameter. Delaying the boundary layer separation up to the end of the cylinder surface can greatly reduce drag. This separation is usually undesirable in engineering applications because considerable amount of energy is lost in the process of eddying.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

a	Acceleration of the element
a	Radius of horizontal circular cylinder
a_c	Lower bound of the domain
α_0	Inclination angle
b_c	Upper bounds of the domain
b	Induced magnetic field
B	Magnetic force
B_0	Magnetic field
Bi	Biot number
C	Nanoparticle concentration
C_f	Specific heat of fluid at constant pressure
C_{fr}	Local skin friction
C_p	Specific heat capacity of nanoparticle material
C_w	Nanoparticle concentration at surface
C_∞	Ambient nanoparticle concentration
$C_{fr}Gr_x^{1/4}$	Reduced skin friction coefficient (free convection)
$C_{fr}\,\mathrm{Re}_x^{1/2}$	Reduced skin friction coefficient (mixed convection)
d_p	Nanoparticle diameter
D_B	Brownian diffusion coefficient
D_T	Thermophoresis coefficient
$\frac{D}{Dt}$	Material derivative

$\mathbf{e}_\mathbf{t}$	Total energy
e_{int}	Internal energy due to random molecular motion
Ec	Eckert number
$\mathbf{E}$	Electric field
f	Similarity function
f'	Velocity profile
f''	Skin friction coefficient
$\mathbf{F}$	Force exerted on fluid element
$\mathbf{F}_{b1}$	Gravitational body forces
$\mathbf{F}_{b2}$	Magnetic force
Gr_x	Local Grashof number
$\mathbf{g}$	Gravitational field
$-g_x$	Gravitational field acting downwards in the $\bar{x}$ direction
h_p	Specific enthalpy of nanoparticle material
h_f	Heat transfer coefficient
$\mathbf{I}$	Identity tensor
$\mathbf{i},\mathbf{j},\mathbf{k}$	Vector components in $\bar{x},\bar{y},\bar{z}$ directions
j_p	Surface mass flux
$\mathbf{j}_p$	Diffusion mass flux for nanoparticle
$\mathbf{j}_{p,B}$	Nanoparticle mass flux due to Brownian diffusion
$\mathbf{j}_{p,T}$	Nanoparticle mass flux due to thermophoretic effect
$\mathbf{J}$	Current density
k_f	Thermal conductivity of fluid

k_B	Boltzmann constant
k_p	Thermal conductivity of fluid particle
k^*	Mean absorption coefficient
L	Length of plate
Le	Lewis number
m	Mass of the element
M	Magnetic parameter
n	Positive constant
N	Concentration buoyancy parameter
Nb	Brownian motion
Nt	Thermophoresis diffusion parameter
$Nu_{\bar{x}}$	Local Nusselt number
$Nu_x Gr_x^{-1/4}$	Reduced Nusselt number (free convection)
$Nu_x \mathrm{Re}_x^{-1/2}$	Reduced Nusselt number (mixed convection)
Pr	Prandtl number
$\overline{p}$	Scalar pressure
$\mathbf{q}$	Energy flux
$\mathbf{q_r}$	Rosseland approximation
q_w	Surface heat flux
R	Radiation parameter
Re_x	Local Reynolds number
$\mathbf{R}_1$	Rivlin-Ericksen tensor
$\mathbf{S}$	Extra stress tensor
S_w	Surface shear stress

S	Surface forces
$Sh_{\bar{x}}$	Local Sherwood number
$Sh_x Gr_x^{-1/4}$	Reduced Sherwood number (free convection)
$Sh_x \mathrm{Re}_x^{-1/2}$	Reduced Sherwood number (mixed convection)
t	Time
tr	Matrix transpose
T	Fluid temperature
T_f	Hot fluid temperature
T_w	Surface temperature
T_∞	Free stream temperature
$\bar{u}, \bar{v}, \bar{w}$	Components of velocity along the $\bar{x}$, $\bar{y}$, $\bar{z}$ directions
$\bar{u}_e$	External velocity for horizontal circular cylinder
$\bar{u}_w$	Velocity of the stretched sheet
U_∞	Free stream velocity
$\mathbf{V}$	Velocity vector
$\mathbf{V}_T$	Thermophoretic velocity
∇	Vector operator
α	Thermal diffusivity
θ	Temperature profile
ϕ	Concentration profile
γ	Mixed convection parameter
λ	Ratio of relaxation to retardation times
λ_1	Retardation time
λ_2	Deborah number

μ	Dynamic viscosity
σ	Electrical conductivity of fluid
σ^*	Stefan-Boltzmann constant
$\boldsymbol{\tau}$	Cauchy stress tensor
$\boldsymbol{\Phi}$	Viscous dissipation
ρ_f	Density of fluid
$\left(\rho C\right)_f$	Effective heat capacity of fluid
ρ_p	Density of nanoparticle
$\left(\rho C\right)_p$	Effective heat capacity of nanoparticle material
ρ_∞	Ambient fluid density
ψ	Stream function
ω	Ratio of effective heat capacity of nanoparticle material and heat capacity of nanofluid.
ν	Kinematic viscosity
μ	Fluid viscosity
$\tilde{\beta}$	Proportionality factor
β_T	Coefficient of thermal expansion
β_C	Coefficient of concentration expansion
δ_h	Momentum boundary layer thickness
δ_T	Thermal boundary layer thickness
δ_c	Concentration boundary layer thickness
O	Of order
η	Boundary layer thickness

LIST OF ABBREVIATIONS

MHD	Magnetohydrodynamics
ODEs	Ordinary Differential Equations
PDEs	Partial Differential Equations
RKF 45	Runge-Kutta-Fehlberg Method

REFERENCES

Abbasi, F. M., Shehzad, S. A., Hayat, T. and Alhuthali, M. S. (2016). Mixed convection flow of Jeffrey nanofluid with thermal radiation and double stratification. Journal of Hydrodynamics, 28(5):840-849.

Abo-Eldahab, E. M., El-Aziz, M. A., Salem, A. M. and Jaber, K. K. (2007). Hall current effect on MHD mixed convection flow from an inclined continuously stretching surface with blowing/suction and internal heat generation/absorption. Applied Mathematical Modelling, 31(9):1829-1846.

Abo-Eldahab, E. M. and El Aziz, M. A. (2004). Blowing/suction effect on hydromagnetic heat transfer by mixed convection from an inclined continuously stretching surface with internal heat generation/absorption. International Journal of Thermal Sciences, 43(7):709-719.

Acrivos, A. (1966). On the combined effect of forced and free convection heat transfer in laminar boundary layer flows. Chemical Engineering Science, 21(4):343-352.

Afridi, M. I., Qasim, M., Khan, I., Shafie, S. and Alshomrani, A. S. (2016). Entropy generation in magnetohydrodynamic mixed convection flow over an inclined stretching sheet. Entropy, 19(1):10.

Afridi, M. I., Qasim, M. and Shafie, S. (2017). Entropy generation in hydromagnetic boundary flow under the effects of frictional and Joule heating: Exact solutions. The European Physical Journal Plus, 132(9):404.

Ahmad, K., Hanouf, Z. and Ishak, A. (2017). MHD Casson nanofluid flow past a wedge with Newtonian heating. The European Physical Journal Plus, 132(2):87.

Ahmad, S. (2009). Convection boundary layer flows over needles and cylinders in viscous fluids. Ph.D Thesis. Universiti Putra Malaysia.

Ahmad, S., Arifin, N. M., Nazar, R. and Pop, I. (2009). Mixed convection boundary layer flow past an isothermal horizontal circular cylinder with temperature-dependent viscosity. International Journal of Thermal Sciences, 48(10):1943-1948.

Ahmed, N., Sharma, D. and Deka, H. (2012). MHD mixed convection and mass transfer from an infinite vertical porous plate with chemical reaction in presence of a heat source. Applied Mathematical Sciences, 6(21):1011-1020.

Akbar, N. S., Ebaid, A. and Khan, Z. H. (2015). Numerical analysis of magnetic field effects on Eyring-Powell fluid flow towards a stretching sheet. Journal of Magnetism Magnetic Materials, 382:355-358.

Akbar, N. S. and Khan, Z. H. (2016). Effect of variable thermal conductivity and thermal radiation with CNTS suspended nanofluid over a stretching sheet with convective slip boundary conditions: Numerical study. Journal of Molecular Liquids, 222:279-286.

Aldos, T. K. and Ali, Y. D. (1997). MHD free forced convection from a horizontal cylinder with suction and blowing. International Communications in Heat and Mass Transfer, 24(5):683-693.

Aldoss, T. K., Ali, Y. D. and Al-Nimr, M. A. (1996). MHD mixed convection from a horizontal circular cylinder. Numerical Heat Transfer, Part A Applications, 30(4):379-396.

Alfvén, H. (1942). Existence of electromagnetic-hydrodynamic waves. Nature, 150(3805):405.

Ali, M., Alim, M. A. and Alam, M. S. (2015). Similarity solution of heat and mass transfer flow over an inclined stretching sheet with viscous dissipation and constant heat flux in presence of magnetic field. Procedia Engineering, 105:557-569.

Anderson, D., Tannehill, J. C. and Pletcher, R. H. (2016). Computational fluid mechanics and heat transfer. CRC Press. New York.

Anderson, J. D. and Wendt, J. (1995). Computational fluid dynamics. Springer. New York.

Anwar, I., Amin, N. and Pop, I. (2008). Mixed convection boundary layer flow of a viscoelastic fluid over a horizontal circular cylinder. International Journal of Non-Linear Mechanics, 43(9):814-821.

Anwar, M. I. (2013). Heat and mass transfer of MHD boundary layer stagnation point flow of nanofluid over a stretching surface. Ph.D Thesis. Universiti Teknologi Malaysia.

Anwar, M. I., Shafie, S., Hayat, T., Shehzad, S. A. and Salleh, M. Z. (2017). Numerical study for MHD stagnation-point flow of a micropolar nanofluid towards a stretching sheet. Journal of the Brazilian Society of Mechanical Sciences and Engineering, 39(1):89-100.

Azim, N. H. M. and Chowdhury, M. K. (2013). MHD-conjugate free convection from an isothermal horizontal circular cylinder with joule heating and heat generation. Journal of Computational Methods in Physics, 2013:1-11.

Baaijens, F. P. T., Selen, S. H. A., Baaijens, H. P. W., Peters, G. W. M. and Meijer, H. E. H. (1997). Viscoelastic flow past a confined cylinder of a low density polyethylene melt. Journal of Non-Newtonian Fluid Mechanics, 68(2):173-203.

Bakar, S. A., Arifin, N. M., Ali, F. M., Bachok, N., Nazar, R. and Pop, I. (2018). A stability analysis on mixed convection boundary layer flow along a permeable vertical cylinder in a porous medium filled with a nanofluid and thermal radiation. Applied Sciences, 8(4):483.

Bataller, R. C. (2008). Radiation effects in the Blasius flow. Applied Mathematics and Computation, 198(1):333-338.

Bejan, A. (2013). Convection heat transfer. John Wiley & Sons. United States.

Bergman, T. L., Incropera, F. P., DeWitt, D. P. and Lavine, A. S. (2011). Fundamentals of heat and mass transfer. John Wiley & Sons. New York.

Bhatti, M. M., Mishra, S. R., Abbas, T. and Rashidi, M. M. (2018). A mathematical model of MHD nanofluid flow having gyrotactic microorganisms with thermal radiation and chemical reaction effects. Neural Computing and Applications, 30(4):1237-1249.

Buongiorno, J. (2006). Convective transport in nanofluids. Journal of Heat Transfer, 128(3):240-250.

Cebeci, T. and Bradshaw, P. (1984). Physical and computational aspects of convective heat transfer. Springer-Verlag. New York.

Chen, C.-H. (2006). Effect of viscous dissipation on heat transfer in a non-Newtonian liquid film over an unsteady stretching sheet. Journal of Non-Newtonian Fluid Mechanics, 135(2):128-135.

Choi, S. U. S. and Eastman, J. A. (1995). Enhancing thermal conductivity of fluids with nanoparticles. In ASME International Mechanical Engineering Congress and Exhibition, Argonne National Lab., IL, United States.

Choi, S. U. S., Zhang, Z. G., Yu, W., Lockwood, F. E. and Grulke, E. A. (2001). Anomalous thermal conductivity enhancement in nanotube suspensions. Applied Physics Letters, 79(14):2252-2254.

Cowling, T. G. (1976). Magnetohydrodynamics. Bristol, Adam Hilger, Ltd. London.

Cramer, K. R. and Pai, S.-I. (1973). Magnetofluid dynamics for engineers and applied physicists. McGraw-Hill. New York.

Crane, L. J. (1970). Flow past a stretching plate. Zeitschrift für angewandte Mathematik und Physik ZAMP, 21(4):645-647.

Dalir, N. (2014). Numerical study of entropy generation for forced convection flow and heat transfer of a Jeffrey fluid over a stretching sheet. Alexandria Engineering Journal, 53(4):769-778.

Dalir, N., Dehsara, M. and Nourazar, S. S. (2015). Entropy analysis for magnetohydrodynamic flow and heat transfer of a Jeffrey nanofluid over a stretching sheet. Energy, 79:351-362.

Darus, A. N. (1994). Dinamik aliran bendalir: Suatu penyelesaian. Dewan Bahasa dan Pustaka. Kuala Lumpur.

Das, K., Acharya, N. and Kundu, P. K. (2015). Radiative flow of MHD Jeffrey fluid past a stretching sheet with surface slip and melting heat transfer. Alexandria Engineering Journal, 54(4):815-821.

Eastman, J. A., Choi, S. U. S., Li, S., Yu, W. and Thompson, L. J. (2001). Anomalously increased effective thermal conductivities of ethylene glycol-based nanofluids containing copper nanoparticles. Applied Physics Letters, 78(6):718-720.

Eastman, J. A., Choi, U. S., Li, S., Thompson, L. J. and Lee, S. (1996). Enhanced thermal conductivity through the development of nanofluids. In Symposium V – Nanophase and Nanocomposite Materials II, Vol. 457, MRS Proceedings.

Eckert, E. R. G. and Jr, R. M. D. (1987). Analysis of heat and mass transfer. McGraw-Hill. New York.

Ellahi, R., Tariq, M. H., Hassan, M. and Vafai, K. (2017). On boundary layer nano-ferroliquid flow under the influence of low oscillating stretchable rotating disk. Journal of Molecular Liquids, 229:339-345.

Farooq, M., Gull, N., Alsaedi, A. and Hayat, T. (2015). MHD flow of a Jeffrey fluid with Newtonian heating. Journal of Mechanics, 31(3):319-329.

Gaffar, S. A., Prasad, V. R. and Reddy, E. K. (2017a). Magnetohydrodynamic free convection flow and heat transfer of non-Newtonian tangent hyperbolic fluid from horizontal circular cylinder with Biot number effects. International Journal of Applied and Computational Mathematics, 3(2):721-743.

Gaffar, S. A., Prasad, V. R. and Vijaya, B. (2017b). Computational study of non-Newtonian Eyring–Powell fluid from a vertical porous plate with Biot number effects. Journal of the Brazilian Society of Mechanical Sciences and Engineering, 39(7):2747-2765.

Ganji, D. D. and Kachapi, S. H. H. (2015). Chapter 4 - Heat transfer in nanofluid. In Application of Nonlinear Systems in Nanomechanics and Nanofluids, 109-180. William Andrew Publishing. Oxford.

Gebhart, B. (1962). Effects of viscous dissipation in natural convection. Journal of fluid Mechanics, 14(2):225-232.

George, K. E. (2009). 2 - Non-Newtonian fluid mechanics and polymer rheology. In Advances in Polymer Processing, 13-46. Woodhead Publishing.

Geropp, D. (1969). Der turbulente wärmeübergang am rotierenden zylinder. Ingenieur-Archiv, 38(4-5):195-203.

Ghadikolaei, S. S., Hosseinzadeh, K., Yassari, M., Sadeghi, H. and Ganji, D. D. (2018). Analytical and numerical solution of non-Newtonian second-grade fluid flow on a stretching sheet. Thermal Science and Engineering Progress, 5:309-316.

Gschwendtner, M. A. (2004). The Eckert number phenomenon: Experimental investigations on the heat transfer from a moving wall in the case of a rotating cylinder. Heat and Mass Transfer, 40(6-7):551-559.

Gupta, P. S. and Gupta, A. S. (1977). Heat and mass transfer on a stretching sheet with suction or blowing. The Canadian Journal of Chemical Engineering, 55(6):744-746.

Gupta, S., Kumar, D. and Singh, J. (2018). MHD mixed convective stagnation point flow and heat transfer of an incompressible nanofluid over an inclined stretching sheet with chemical reaction and radiation. International Journal of Heat and Mass Transfer, 118:378-387.

Halim, N. A., Haq, R. U. and Noor, N. F. M. (2017). Active and passive controls of nanoparticles in Maxwell stagnation point flow over a slipped stretched surface. Meccanica, 52(7):1527-1539.

Haq, R. U., Nadeem, S., Khan, Z. H. and Akbar, N. S. (2015). Thermal radiation and slip effects on MHD stagnation point flow of nanofluid over a stretching sheet. Physica E: Low-dimensional Systems and Nanostructures, 65:17-23.

Hartmann, J. and Lazarus, F. (1937). Hg-dynamics I: Theory of the laminar flow of an electrically conductive liquid in a homogeneous magnetic field. Levin & Munksgaard Copenhagen.

Hayat, T., Asad, S. and Alsaedi, A. (2015a). Flow of Burgers' fluid over an inclined stretching sheet with heat and mass transfer. Journal of Central South University, 22(8):3180-3188.

Hayat, T., Ashraf, M. B., Shehzad, S. A. and Bayomi, N. N. (2015b). Mixed convection flow of viscoelastic nanofluid over a stretching cylinder. Journal of the Brazilian Society of Mechanical Sciences and Engineering, 37(3):849-859.

Hayat, T., Aziz, A., Muhammad, T. and Alsaedi, A. (2017a). Active and passive controls of Jeffrey nanofluid flow over a nonlinear stretching surface. Results in Physics, 7:4071-4078.

Hayat, T., Aziz, A., Muhammad, T. and Alsaedi, A. (2017b). A revised model for Jeffrey nanofluid subject to convective condition and heat generation/absorption. PloS One, 12(2):e0172518.

Hayat, T., Iqbal, Z., Mustafa, M. and Alsaedi, A. (2014). Unsteady flow and heat transfer of Jeffrey fluid over a stretching sheet. Thermal Science, 18(4):1069-1078.

Hayat, T., Qayyum, S. and Alsaedi, A. (2017c). Mechanisms of nonlinear convective flow of Jeffrey nanofluid due to nonlinear radially stretching sheet with convective conditions and magnetic field. Results in Physics, 7:2341-2351.

Hayat, T., Saif, R. S., Ellahi, R., Muhammad, T. and Alsaedi, A. (2018). Simultaneous effects of melting heat and internal heat generation in stagnation point flow of Jeffrey fluid towards a nonlinear stretching surface with variable thickness. International Journal of Thermal Sciences, 132:344-354.

Hayat, T., Waqas, M., Khan, M. I. and Alsaedi, A. (2017d). Impacts of constructive and destructive chemical reactions in magnetohydrodynamic (MHD) flow of Jeffrey liquid due to nonlinear radially stretched surface. Journal of Molecular Liquids, 225:302-310.

Hussain, A., Malik, M. Y., Awais, M., Salahuddin, T. and Bilal, S. (2019). Computational and physical aspects of MHD Prandtl-Eyring fluid flow analysis over a stretching sheet. Neural Computing and Applications, 31(1):425-433.

Hussain, T., Shehzad, S. A., Hayat, T., Alsaedi, A., Al-Solamy, F. and Ramzan, M. (2014). Radiative hydromagnetic flow of Jeffrey nanofluid by an exponentially stretching sheet. Plos One, 9(8):e103719.

Ibáñez, G. (2015). Entropy generation in MHD porous channel with hydrodynamic slip and convective boundary conditions. International Journal of Heat and Mass Transfer, 80:274-280.

Ibrahim, W., Haq, R. U. and Engineering (2016). Magnetohydrodynamic (MHD) stagnation point flow of nanofluid past a stretching sheet with convective boundary condition. Journal of the Brazilian Society of Mechanical Sciences, 38(4):1155-1164.

Ingham, D. B. and Pop, I. (1987). Natural convection about a heated horizontal cylinder in a porous medium. Journal of Fluid Mechanics, 184:157-181.

Ishak, A. (2008). Penyelesaian keserupaan bagi aliran lapisan sempadan olakan dalam bendalir likat. Ph.D Thesis. Universiti Kebangsaan Malaysia.

Ishak, A., Nazar, R., Bachok, N. and Pop, I. (2010). MHD mixed convection flow near the stagnation-point on a vertical permeable surface. Physica A: Statistical Mechanics and its Applications, 389(1):40-46.

Ishak, A., Nazar, R. and Pop, I. (2006). Unsteady mixed convection boundary layer flow due to a stretching vertical surface. Arabian Journal for Science and Engineering, 31(2):165-182.

Ishak, A., Nazar, R. and Pop, I. (2007). Mixed convection on the stagnation point flow toward a vertical, continuously stretching sheet. Journal of Heat Transfer, 129(8):1087-1090.

Ishak, A., Nazar, R. and Pop, I. (2008). Post-stagnation-point boundary layer flow and mixed convection heat transfer over a vertical, linearly stretching sheet. Archives of Mechanics, 60(4):303-322.

Jaluria, Y. (1980). Natural convection: Heat and mass transfer. Pergamon Press. Oxford, England.

Jha, B. K. and Ajibade, A. O. (2012). Effect of viscous dissipation on natural convection flow between vertical parallel plates with time-periodic boundary conditions. Communications in Nonlinear Science and Numerical Simulation, 17(4):1576-1587.

Jiji, L. M. and Jiji, L. M. (2006). Heat convection. Springer. Berlin, Heidelberg.

Joshi, N. D. and Sukhatme, S. P. (1971). An analysis of combined free and forced convection heat transfer from a horizontal circular cylinder to a transverse flow. Journal of Heat Transfer, 93(4):441-448.

Kakac, S., Yener, Y. and Pramuanjaroenkij, A. (2013). Convective heat transfer. CRC Press.

Kasim, A. R. M. (2013). Convective boundary layer flow of viscoelastic fluid. Universiti Teknologi Malaysia.

Kasim, A. R. M., Mohammad, N. F., Shafie, S. and Pop, I. (2013). Constant heat flux solution for mixed convection boundary layer viscoelastic fluid. Heat and Mass Transfer, 49(2):163-171.

Kaviany, M. (2002). Principles of heat transfer. John Wiley & Sons. New York.

Kays, W. M. (2005). Convective heat and mass transfer. McGraw-Hill. Boston MA, London.

Keller, H. B. (1971). A new difference scheme for parabolic problems. In Numerical Solution of Partial Differential Equations–II, 327-350. Elsevier.

Keller, H. B. (1978). Numerical methods in boundary-layer theory. Annual Review of Fluid Mechanics, 10(1):417-433.

Keller, H. B. and Cebeci, T. (1972). Accurate numerical methods for boundary-layer flows. II: Two dimensional turbulent flows. AIAA Journal, 10(9):1193-1199.

Khan, S. M., Hammad, M. and Sunny, D. A. (2017). Chemical reaction, thermal relaxation time and internal material parameter effects on MHD viscoelastic fluid with internal structure using the Cattaneo-Christov heat flux equation. The European Physical Journal Plus, 132(8):338.

Khan, W. A. and Pop, I. (2010). Boundary-layer flow of a nanofluid past a stretching sheet. International Journal of Heat and Mass Transfer, 53(11):2477-2483.

Khlebtsov, N. G., Trachuk, L. A. and Mel'nikov, A. G. (2005). The effect of the size, shape, and structure of metal nanoparticles on the dependence of their optical properties on the refractive index of a disperse medium. Optics and Spectroscopy, 98(1):77-83.

Krishnamurthy, M. R., Prasannakumara, B. C., Gireesha, B. J. and Gorla, R. S. R. (2016). Effect of chemical reaction on MHD boundary layer flow and melting heat transfer of Williamson nanofluid in porous medium. Engineering Science and Technology, an International Journal, 19(1):53-61.

Krishnan, A. R. and Jinshah, B. (2013). Magnetohydrodynamic power generation. International Journal of Scientific and Research Publications, 3:1-11.

Kumari, M., Pop, I. and Nath, G. (1987). Mixed convection boundary layer flow over a sphere in a saturated porous medium. ZAMM-Journal of Applied Mathematics and Mechanics/Zeitschrift für Angewandte Mathematik und Mechanik, 67(11):569-572.

Kumari, M., Slaouti, A., Takhar, H. S., Nakamura, S. and Nath, G. (1996). Unsteady free convection flow over a continuous moving vertical surface. Acta Mechanica, 116(1-4):75-82.

Kuznetsov, A. V. and Nield, D. A. (2013). The Cheng–Minkowycz problem for natural convective boundary layer flow in a porous medium saturated by a nanofluid: A revised model. International Journal of Heat and Mass Transfer, 65:682-685.

Leal, L. G. (1992). Laminar flow and convective transport processes: Scaling principles and asymptotic analysis. Heinemann. Butterworth.

Lok, Y. Y., Amin, N., Campean, D. and Pop, I. (2005). Steady mixed convection flow of a micropolar fluid near the stagnation point on a vertical surface. International Journal of Numerical Methods for Heat & Fluid Flow, 15(7):654-670.

Lok, Y. Y., Amin, N. and Pop, I. (2006). Unsteady mixed convection flow of a micropolar fluid near the stagnation point on a vertical surface. International Journal of Thermal Sciences, 45(12):1149-1157.

Mahat, R., Rawi, N. A., Kasim, A. R. M. and Shafie, S. (2018). Mixed convection flow of viscoelastic nanofluid past a horizontal circular cylinder with viscous dissipation. Sains Malaysiana, 47(7):1617-1623.

Makanda, G., Shaw, S. and Sibanda, P. (2015). Effects of radiation on MHD free convection of a Casson fluid from a horizontal circular cylinder with partial slip in non-Darcy porous medium with viscous dissipation. Boundary Value Problems, 2015(1):75.

Makinde, O. D. (2011). Similarity solution for natural convection from a moving vertical plate with internal heat generation and a convective boundary condition. Thermal Science, 15(suppl. 1):137-143.

Makinde, O. D. and Olanrewaju, P. O. (2010). Buoyancy effects on thermal boundary layer over a vertical plate with a convective surface boundary condition. Journal of Fluids Engineering, 132(4):044502.

McCormack, P. D. and Crane, L. (1973). Physical fluid dynamics. Academic Press, Inc. United States.

Mehmood, A. and Usman, M. (2018). Controlling boundary layer separation in stretching sheet flow. Alexandria Engineering Journal, 57(4):3747-3753.

Merkin, J. H. (1976). Free convection boundary layer on an isothermal horizontal cylinder. In American Society of Mechanical Engineers and American Institute of Chemical Engineers, Heat Transfer Conference.

Merkin, J. H. (1977a). Free convection boundary layers on cylinders of elliptic cross section. Journal of Heat Transfer, 99(3):453-457.

Merkin, J. H. (1977b). Mixed convection from a horizontal circular cylinder. International Journal of Heat and Mass Transfer, 20(1):73-77.

Merkin, J. H. and Pop, I. (1988). A note on the free convection boundary layer on a horizontal circular cylinder with constant heat flux. Wärme-und Stoffübertragung, 22(1-2):79-81.

Merkin, J. H. and Pop, I. (2011). The forced convection flow of a uniform stream over a flat surface with a convective surface boundary condition. Communications in Nonlinear Science and Numerical Simulation, 16(9):3602-3609.

Mohamad, N. F. (2015). Magnetohydrodynamic flow past a sphere in a viscous and micropolar fluid for unsteady free and mixed convective boundary layer. Ph.D Thesis. Universiti Teknologi Malaysia

Mohamed, M. K. A. (2017). Steady convective boundary layer flow in a nanofluid past on a bluff body with the viscous dissipation effect. Ph.D Thesis. Universiti Malaysia Pahang.

Mohamed, M. K. A., Noar, N. A. Z., Salleh, M. Z. and Ishak, A. (2016a). Mathematical model of boundary layer flow over a moving plate in a nanofluid with viscous dissipation. Journal of Applied Fluid Mechanics, 9(5).

Mohamed, M. K. A., Noar, N. A. Z. M., Salleh, M. Z. and Ishak, A. (2016b). Free convection boundary layer flow on a horizontal circular cylinder in a nanofluid with viscous dissipation. Sains Malaysiana, 45(2):289-296.

Mohamed, M. K. A., Salleh, M. Z., Ishak, A. and Pop, I. (2015). Stagnation point flow and heat transfer over a stretching/shrinking sheet in a viscoelastic fluid with convective boundary condition and partial slip velocity. The European Physical Journal Plus, 130(8):171-179.

Mohamed, M. K. A., Salleh, M. Z., Noar, N. A. Z. M. and Ishak, A. (2016c). The viscous dissipation effects on the mixed convection boundary layer flow on a horizontal circular cylinder. Jurnal Teknologi, 78(4-4):73-79.

Mohamed, M. K. A., Sarif, N. M., Noar, N. A. Z. M., Salleh, M. Z. and Ishak, A. M. (2018). Mixed convection boundary layer flow on a horizontal circular cylinder in a nanofluid with viscous dissipation effect. Malaysian Journal of Fundamental and Applied Sciences, 14(1):32-39.

Molla, M. M., Hossain, M. A. and Gorla, R. S. R. (2005). Natural convection flow from an isothermal horizontal circular cylinder with temperature dependent viscosity. Heat and Mass Transfer, 41(7):594-598.

Molla, M. M., Hossain, M. A. and Paul, M. C. (2006). Natural convection flow from an isothermal horizontal circular cylinder in presence of heat generation. International Journal of Engineering Science, 44(13):949-958.

Morini, G. L. (2008). Viscous dissipation. In Encyclopedia of Microfluidics and Nanofluidics, 2155-2164. Springer. Boston, MA.

Moutsoglou, A., Tzuoo, K. and Chen, T. (1980). Mixed convection in boundary layer flows over inclined surfaces. In 15th Thermophysics Conference, 1525, American Institute of Aeronautics and Astronautics, New York.

Mucoglu, A. and Chen, T. S. (1978). Mixed convection about a sphere with uniform surface heat flux. Journal of Heat Transfer, 100(3):542-544.

Na, T. Y. (1980). Computational methods in engineering boundary value problems. Academic Press.

Nadeem, S., Haq, R. U., Akbar, N. S. and Khan, Z. H. (2013). MHD three-dimensional Casson fluid flow past a porous linearly stretching sheet. Alexandria Engineering Journal, 52(4):577-582.

Nandeppanavar, M. M. (2018). Melting heat transfer analysis of non-Newtonian Casson fluid due to moving plate. Engineering Computations, 35(3):1301-1313.

Narayana, P. V. S. and Babu, D. H. (2016). Numerical study of MHD heat and mass transfer of a Jeffrey fluid over a stretching sheet with chemical reaction and thermal radiation. Journal of the Taiwan Institute of Chemical Engineers, 59:18-25.

Nazar, R. (2003). Mathematical model for free and mixed convection boundary layer flows of micropolar fluids. Ph.D Thesis. Universiti Teknologi Malaysia.

Nazar, R., Amin, N., Filip, D. and Pop, I. (2003a). The Brinkman model for the mixed convection boundary layer flow past a horizontal circular cylinder in a porous medium. International Journal of Heat and Mass Transfer, 46(17):3167-3178.

Nazar, R., Amin, N. and Pop, I. (2002). Free convection boundary layer on an isothermal horizontal circular cylinder in a micropolar fluid. Heat Transfer, 2:525-530.

Nazar, R., Amin, N. and Pop, I. (2004). Mixed convection boundary layer flow from a horizontal circular cylinder in a micropolar fluid: Case of constant wall heat flux. International Journal of Fluid Mechanics Research, 31(2):1-17.

Nazar, R., Amin, N., Pop, I. and Flow, F. (2003b). Mixed convection boundary-layer flow from a horizontal circular cylinder in micropolar fluids: Case of constant wall temperature. International Journal of Numerical Methods for Heat, 13(1):86-109.

Nazar, R., Tham, L., Pop, I. and Ingham, D. B. (2011). Mixed convection boundary layer flow from a horizontal circular cylinder embedded in a porous medium filled with a nanofluid. Transport in porous media, 86(2):517-536.

Oertel, H. (2004). Prandtl's essentials of fluid mechanics. Springer Science & Business Media. United State of America.

Ozisik, M. N. (1985). Heat transfer: A basic approach. McGraw-Hill. New York.

Pop, I. and Ingham, D. B. (2001). Convective heat transfer: Mathematical and computational modelling of viscous fluids and porous media. Elsevier.

Pop, I., Naganthran, K., Nazar, R. and Ishak, A. (2017). The effect of vertical throughflow on the boundary layer flow of a nanofluid past a stretching/shrinking sheet: A revised model. International Journal of Numerical Methods for Heat & Fluid Flow, 27(9):1910-1927.

Prasad, V. R., Gaffar, S. A., Reddy, E. K. and Bég, O. A. (2014). Flow and heat transfer of Jeffreys non-Newtonian fluid from horizontal circular cylinder. Journal of Thermophysics and Heat Transfer, 28(4):764-770.

Prasad, V. R., Gaffar, S. A., Reddy, E. K. and Bég, O. A. (2015). Numerical study of non-Newtonian Jeffreys fluid from a permeable horizontal isothermal cylinder in non-Darcy porous medium. Journal of the Brazilian Society of Mechanical Sciences and Engineering, 37(6):1765-1783.

Qasim, M. (2013). Heat and mass transfer in a Jeffrey fluid over a stretching sheet with heat source/sink. Alexandria Engineering Journal, 52(4):571-575.

Qasim, M., Hayat, T. and Obaidat, S. (2012). Radiation effect on the mixed convection flow of a viscoelastic fluid along an inclined stretching sheet. Zeitschrift für Naturforschung A, 67(3-4):195-202.

Qasim, M., Khan, I. and Shafie, S. (2013). Heat transfer in a micropolar fluid over a stretching sheet with Newtonian heating. PLoS One, 8(4):e59393.

Qayyum, S., Hayat, T., Alsaedi, A. and Ahmad, B. (2017). Magnetohydrodynamic (MHD) nonlinear convective flow of Jeffrey nanofluid over a nonlinear stretching surface with variable thickness and chemical reaction. International Journal of Mechanical Sciences, 134:306-314.

Rahman, M. M. and Eltayeb, I. A. (2013). Radiative heat transfer in a hydromagnetic nanofluid past a non-linear stretching surface with convective boundary condition. Meccanica, 48(3):601-615.

Ramesh, G. K., Chamkha, A. J. and Gireesha, B. J. (2013). MHD mixed convection flow of a viscoelastic fluid over an inclined surface with a nonuniform heat source/sink. Canadian Journal of Physics, 91(12):1074-1080.

Ramesh, G. K., Shehzad, S. A., Hayat, T. and Alsaedi, A. (2018). Activation energy and chemical reaction in Maxwell magneto-nanoliquid with passive control of nanoparticle volume fraction. Journal of the Brazilian Society of Mechanical Sciences and Engineering, 40(9):422.

Ramzan, M., Bilal, M. and Chung, J. D. (2017a). Effects of thermal and solutal stratification on Jeffrey magneto-nanofluid along an inclined stretching cylinder with thermal radiation and heat generation/absorption. International Journal of Mechanical Sciences, 131-132:317-324.

Ramzan, M., Bilal, M. and Chung, J. D. (2017b). Influence of homogeneous-heterogeneous reactions on MHD 3D Maxwell fluid flow with Cattaneo-Christov heat flux and convective boundary condition. Journal of Molecular Liquids, 230:415-422.

Ramzan, M., Farooq, M., Hayat, T. and Chung, J. D. (2016). Radiative and Joule heating effects in the MHD flow of a micropolar fluid with partial slip and convective boundary condition. Journal of Molecular Liquids, 221:394-400.

Rao, A. S., Amanulla, C. H., Nagendra, N., Bég, O. A. and Kadir, A. (2017). Hydromagnetic flow and heat transfer in a Williamson Non-Newtonian fluid from a horizontal circular cylinder with Newtonian heating. International Journal of Applied and Computational Mathematics, 3(4):3389-3409.

Rashad, A. M., Chamkha, A. J. and Modather, M. (2013). Mixed convection boundary-layer flow past a horizontal circular cylinder embedded in a porous medium filled with a nanofluid under convective boundary condition. Computers & Fluids, 86:380-388.

Reddy, M. G., Reddy, S. and Rama, G. (2017a). Micropolar fluid flow over a nonlinear stretching convectively heated vertical surface in the presence of Cattaneo-Christov heat flux and viscous dissipation. Frontiers in Heat and Mass Transfer, 8(20):1-9.

Reddy, P. S., Chamkha, A. J. and Al-Mudhaf, A. (2017b). MHD heat and mass transfer flow of a nanofluid over an inclined vertical porous plate with radiation and heat generation/absorption. Advanced Powder Technology, 28(3):1008-1017.

Rogers, D. F. (1992). Laminar flow analysis. Cambridge University Press.

Rollins, D. and Vajravelu, K. (1991). Heat transfer in a second-order fluid over a continuous stretching surface. Acta Mechanica, 89(1-4):167-178.

Sakiadis, B. C. (1961). Boundary-layer behavior on continuous solid surfaces: III. The boundary layer on a continuous cylindrical surface. AIChE Journal, 7(3):467-472.

Salleh, M. Z. (2011). Pemodelan matematik bagi aliran lapisan sempadan olakan dengan pemanasan Newtonan. Ph.D. Universiti Kebangsaan Malaysia.

Salleh, M. Z. and Nazar, R. (2010). Free convection boundary layer flow over a horizontal circular cylinder with Newtonian heating. Sains Malaysiana, 39(4):671-676.

Salleh, M. Z., Nazar, R. and Pop, I. (2009). Forced convection boundary layer flow at a forward stagnation point with Newtonian heating. Chemical Engineering Communications, 196(9):987-996.

Salleh, M. Z., Nazar, R. and Pop, I. (2010). Boundary layer flow and heat transfer over a stretching sheet with Newtonian heating. Journal of the Taiwan Institute of Chemical Engineers, 41(6):651-655.

Salleh, M. Z., Nazar, R. and Pop, I. (2012). Numerical solutions of free convection boundary layer flow on a solid sphere with Newtonian heating in a micropolar fluid. Meccanica, 47(5):1261-1269.

Sandeep, N. and Sulochana, C. (2016). Momentum and heat transfer behaviour of Jeffrey, Maxwell and Oldroyd-B nanofluids past a stretching surface with non-uniform heat source/sink. Ain Shams Engineering Journal, 9(4):517-524.

Schlichting, H. and Gersten, K. (2016). Boundary-layer theory. Springer. New York.

Seiichi, N. and Takuro, O. (1975). Heat transfer from a horizontal circular wire at small reynolds and grashof numbers—II: Mixed convection. International Journal of Heat and Mass Transfer, 18(3):397-413.

Shafie, S., Amin, N. and Pop, I. (2005). The effect of g-jitter on double diffusion by natural convection from a sphere. International Journal of Heat and Mass Transfer, 48(21-22):4526-4540.

Shafie, S., Amin, N. and Pop, I. (2007). g-Jitter free convection flow in the stagnation-point region of a three-dimensional body. Mechanics Research Communications, 34(2):115-122.

Shahzad, F., Sagheer, M. and Hussain, S. (2018). Numerical simulation of magnetohydrodynamic Jeffrey nanofluid flow and heat transfer over a stretching sheet considering Joule heating and viscous dissipation. AIP Advances, 8(6):065316.

Shehzad, S. A., Abdullah, Z., Alsaedi, A., Abbasi, F. M. and Hayat, T. (2016). Thermally radiative three-dimensional flow of Jeffrey nanofluid with internal heat generation and magnetic field. Journal of Magnetism and Magnetic Materials, 397:108-114.

Sheikholeslami, M. (2018). Application of Darcy law for nanofluid flow in a porous cavity under the impact of Lorentz forces. Journal of Molecular Liquids, 266:495-503.

Shenoy, A. V. (2013). Rheology of filled polymer systems. Springer Netherlands.

Shercliff, J. A. (1965). Textbook of magnetohydrodynamics. Pergamon Press. Oxford.

Soomro, F. A., Khan, Z. H. and Zhang, Q. (2017). Numerical study of entropy generation in MHD water-based carbon nanotubes along an inclined permeable surface. The European Physical Journal Plus, 132(10):412.

Sparrow, E. M. and Lee, L. (1976). Analysis of mixed convection about a horizontal cylinder. International Journal of Heat and Mass Transfer, 19:229-232.

Sravanthi, C. S. (2016). Homotopy analysis solution of MHD slip flow past an exponentially stretching inclined sheet with Soret-Dufour effects. Journal of the Nigerian Mathematical Society, 35(1):208-226.

Tham, L., Nazar, R. and Pop, I. (2012). Mixed convection boundary layer flow from a horizontal circular cylinder in a nanofluid. International Journal of Numerical Methods for Heat & Fluid Flow, 22(5):576-606.

Tiwari, R. K. and Das, M. K. (2007). Heat transfer augmentation in a two-sided lid-driven differentially heated square cavity utilizing nanofluids. International Journal of Heat and Mass Transfer, 50(9-10):2002-2018.

Ullah, I., Khan, I. and Shafie, S. (2017). Soret and Dufour effects on unsteady mixed convection slip flow of Casson fluid over a nonlinearly stretching sheet with convective boundary condition. Scientific Reports, 7(1):1113.

Vajravelu, K. and Prasad, K. V. (2014). Keller-box method and its application. Walter de Gruyter GmbH & Co KG. Berlin/Boston.

Vijayalaxmi, T. and Shankar, B. (2016). Hydromagnetic flow and heat transfer of Williamson nanofluid over an inclined exponential stretching sheet in the presence of thermal radiation and chemical reaction with slip conditions. Journal of Nanofluids, 5(6):826-838.

Waqas, M., Farooq, M., Khan, M. I., Alsaedi, A., Hayat, T. and Yasmeen, T. (2016). Magnetohydrodynamic (MHD) mixed convection flow of micropolar liquid due to nonlinear stretched sheet with convective condition. International Journal of Heat and Mass Transfer, 102:766-772.

Wickern, G. (1991). Mixed convection from an arbitrarily inclined semi-infinite flat plate-I. The influence of the inclination angle. International Journal of Heat and Mass Transfer, 34(8):1935-1945.

Wilks, G. and Hunt, R. (1981). The assimilation of a strong, two-dimensional laminar jet into an aligned uniform stream. Proceedings of the Royal Society of Edinburgh: Section A Mathematics, 90(1-2):13-23.

Wilks, G. and Hunt, R. (1986). The axisymmetric, turbulent, buoyant jet—numerical solution for a semiempirical theory. Numerical Heat Transfer, Part A: Applications, 9(4):495-509.

Wilks, G. and Hunt, R. (1987). Vertical mixed convection flow about a horizontal line source of heating or cooling. International Journal of Heat and Mass Transfer, 30(6):1119-1131.

Yu, W., France, D. M., Routbort, J. L. and Choi, S. U. S. (2008). Review and comparison of nanofluid thermal conductivity and heat transfer enhancements. Heat Transfer Engineering, 29(5):432-460.

Zhang, X. (2006). A numerical and experimental study of a dynamic resonant shear stress sensor. Ph.D. University of Wyoming.